DOCUMENT RESUME

ED 457 000 SE 065 144

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TITLE The Lattice Method Used in Teaching Multiplication with Whole Numbers and Decimals to Students with Learning Disabilities.
PUB DATE 2001-10-00
NOTE 41p.
PUB TYPE Guides - Non-Classroom (055) -- Numerical/Quantitative Data (110) -- Reports - Research (143)
EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Decimal Fractions; Elementary Secondary Education; *Learning Disabilities; Mathematics Education; *Multiplication; *Number Concepts; *Special Education
IDENTIFIERS *Lattice Theory

ABSTRACT

The purpose of the study was to help teachers understand the importance of using the Lattice Method in teaching multiplication with whole numbers and decimals to students with learning disabilities. The common errors made by learning disabled students in multiplication with whole numbers were analyzed. In the study, students with learning disabilities were able to do multiplication by the traditional way only with 15% accuracy, but they skillfully used the Lattice Method to multiply more than 2 digit numbers with more than 97% accuracy. Special education teachers who used the method to teach their students multiplication with whole numbers and decimals achieved great success in their classes. The method ensured that students with learning disabilities avoided misplacing place value and other errors in multiplying algorithms. Proper instructions greatly reduced the repetition of student errors in multiplication. It was also found that students were not able to multiply two or three digits in the traditional way, but they were able to multiply two or more digits with the Lattice Method in accuracy ranging from 90% to 100%. In addition, the method was used to teach decimal multiplication to students with learning disabilities very effectively. Overall, statistically significant differences between the two tests were found on the pre-test (significant at the 0.01 level) and the post-test (significant at the 0.05 level) on the basis of the formula of Chi-square. Students obtained much higher scores in the test with the Lattice Method than with the traditional way of multiplication. Above all, this method improved self-esteem and self-confidence in the students. (YDS)

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The Lattice Method Used in Teaching Multiplication with Whole Numbers and Decimals to Students with Learning Disabilities

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Presented

to

Eagleton School, Massachusetts

and

Department of Special Education

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by

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October 2001

SE065144

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ACKNOWLEDGEMENTS

The writer wishes to express his great gratitude to the following people, who encouraged, supported, and used the Lattice Method for teaching multiplication to students with special education, and assisted in the development of the method: Tricia Brown (former colleague), a certified special education teacher and Vice Principal in Sacramento, California; Scott Kober (former colleague), a certified special education teacher in Alaska; Joye Shirks, a certified special education teacher in Wisconsin; Tim Shirks, a certified special education teacher in Minnesota; Kent Kramer, a certified special education teacher in Wisconsin; Anpei Jiang, a certified special education teacher in New Jersey; Sherry Xiao Peng, a certified special education teacher in California; Mary Qin, a certified special education teacher in New York; Aaron Fisher (former colleague), a certified special education teacher and Director of Education, Academy at Swift River, Massachusetts; Katherine Foster, a certified special education teacher in Lee Public School District, Massachusetts; Shirley McLellan, a certified special education teacher of New York; Lynn Summerill, a certified special education teacher and Director of Education of Eagleton School, Massachusetts; Toney Lee, special education teacher of Eagleton School, Massachusetts; Bruce Bona, Executive Director of Eagleton School, Massachusetts; Zujue Ding, M.A., Brooklyn Public Library, New York City; Dr. Palmer Lylle, Professor of Special Education, Winona State University, Minnesota; Dr. Frank Rocco, Professor of Special Education and Chairperson of Department of Special Education, Winona State University, Minnesota; Dr. Patricia Tolmie, Professor, Department of Education, Winona State University, Minnesota; Dr.Xinsheng Cai, Peabody College at Vanderbilt University, Tennessee; Dr. Jianjing Ling, Economist, American Express New York City; and Xiaomei Xu, MD.M.S., Ontario, California.

The writer is also deeply grateful to his students who have had a good cooperation with him in learning the unique Lattice Method used in multiplication with whole numbers and decimals. E-mail address of the writer: gu0707@hotmail.com

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Abstract

The purpose of the study was not only to help teachers understand the importance of using the Lattice Method in teaching multiplication with whole numbers and decimals to students with Learning Disabilities, but also to let teachers know how to teach multiplication with whole numbers and decimals to students with Learning disabilities by using the Lattice Method in order for teachers to better improve academic levels for students with Learning Disabilities in learning multiplication with whole numbers and decimals.

Moreover, the writer analyzed the common errors made by these students in multiplication with whole numbers and introduced the method to teachers in many schools throughout the nation. Success made in using the method was reported from special education teachers from other states. It was found that in the writer's classes students with Learning Disabilities were able to do multiplication by the traditional way only with 15 % accuracy, but they skillfully used the Lattice Method to multiply more than 2 digits numbers with more than 97% accuracy. Special education teachers in other states who used the Method to teach their students multiplication with whole numbers and decimals also achieved great success in their classes.

As is known to all, students made a wide variety of errors in multiplication with whole numbers and decimals, especially students with Learning Disabilities. The writer used the Lattice Method to teach multiplication to the students with Learning Disabilities in Eagleton School. Practice proved that the Lattice Method was very useful and practical to those students in learning how to multiply with whole numbers and decimals. The method ensured students with Learning Disabilities to avoid misplacing place value and other errors in multiplication algorithms. These errors indicated clearly that there were many ways to do a few things wrong. Proper instructions greatly reduced the repetition of student errors in multiplication. It was also found that students were not able to multiply two or three digits in the traditional way, but they were able to multiply two or more than two digits with the Lattice Method in accuracy ranging from 90% to 100%. In addition,

the method was used to teach decimal multiplication to students with Learning Disabilities every effectively. Overall, statistically significant differences between the two tests were found on the pre-test (significant at the 0.01 level) and the post-test (significant at the 0.05 level) on the basis of the formula of Chi-square. Students obtained much higher scores in the test with the Lattice Method than with the traditional way of multiplication.

In a word, students with Learning Disabilities made fewer errors when they used this method than they used the traditional way of multiplication. Thus it ensured the accuracy of multiplication with whole numbers and decimals when students did long multiplication. The writer introduced and illustrated in detail how to teach students with Learning Disabilities multiplication with this quick and easy Lattice Method.

The writer emphasized that the Lattice Method, if properly instructed, could help students with Learning Disabilities to overcome much difficulty in multiplication with whole numbers and decimals. Most importantly, students with Learning Disabilities were able to do multiplication with the Lattice Method better than with the traditional way. Above all, this method improved self-esteem and self-confidence in the students for their academic learning. It is hoped that more and more special education teachers will use the Lattice Method to teach students with Learning Disabilities multiplication with whole numbers and decimals. The method will continue to have an impact on the improvement of academic performance in multiplication with whole numbers and decimals to students with special education.

Chapter I

Introduction

In the past four years, the writer used the Lattice Method to teach the students with Learning Disabilities in Eagleton School, Massachusetts. The method was very helpful to those students in doing multiplication with whole numbers and decimals. The result of the implementation of the Lattice Method proved to be satisfying.

The purpose of the study was to help teachers to further understand the great importance of using the Lattice Method in teaching multiplication with whole numbers and decimals to students with Learning Disabilities because these students made a wide variety of errors in multiplication algorithms. The writer analyzed the common errors made by these students in multiplication with whole numbers and introduced the method to teachers in many schools throughout the nation. Success made in using the method was reported from special education teachers from other states (*Excerpts in Appendix B*). Detail in how to use the Lattice Method was introduced and illustrated step by step in the following chapters.

The Lattice Method is a quick and different way to multiply more than two numbers. In a traditional way of multiplication, students needed to regroup when they multiplied by a 2-digit factor. Students can make errors in multiplication especially with two- and three-digit multipliers. When doing multiplication with whole numbers, for example, they wrote entire product of each column without regrouping. They wrote tens value of each subproduct, and regrouped ones value into next column, wrote one value of each subproduct, but didn't regroup tens value into next column, and had no cross-multiplication and so on and so forth. But the Lattice Method definitely helped students with Learning Disabilities to overcome these common errors made in multiplication with whole numbers and decimals. It was found that students with Learning Disabilities made fewer errors when they used this method than they used the traditional way of multiplication. Thus it ensured the accuracy of multiplication when students did long digit multiplication. Most importantly, this method improved self-esteem and self-confidence in the students for their academic learning.

Chapter II

The problem

The purpose of this study was to help teachers of special education further understand the great importance in using the Lattice Method for teaching students with Learning Disabilities how to multiply whole numbers and decimals.

Students with Learning Disabilities often made errors in multiplication, especially in long multiplication. It was found that students with Learning Disabilities made multiplication errors owing to lack of proficiency in basic number facts.[5] Students wrote entire product of each column without regrouping. They wrote tens value of each other subproduct and regrouped ones value into next column. They wrote one value of each subproduct, but didn't regroup tens value into next column. They added digits of multiplicands and multiplied. They misjudged computation signs. They did not use cross-multiplication and misplaced place value.[6] These errors were the commonly made errors by students with Learning Disabilities with the traditional way of multiplication. These errors clearly indicated that there were many ways to do a few things wrong. Proper and clear instructions can greatly reduce the repetition of student errors in computation.

The writer emphasized that the Lattice Method, if properly instructed, could help students with Learning Disabilities to overcome much difficulty in multiplication. Most importantly, students with Learning Disabilities were able to do multiplication with the Lattice Method better than with the traditional way of multiplication. Students with Learning Disabilities also had trouble in multiplying decimals. They didn't know what to do with complex decimals. For example, 2.35×0.306 confused them very much.

In the writer's classes students were able to do multiplication with the traditional way, the accuracy of which was only 15%, but they skillfully used the Lattice Method to multiply with more than 2 digits numbers with more than 97 % accuracy.

Chapter III

Procedures

The writer reviewed some literature about the use of the Lattice Method, but it was found that there was hardly any literature to show the benefit of using the Lattice Method for teaching students with Learning Disabilities or those who had trouble in multiplying whole numbers and decimals. Common errors made by students with Learning Disabilities were analyzed and further explanation and illustration in how to use the Lattice Method was shown.

A. Common Errors Found in the Traditional Way of Multiplication

As is known to all, students made a wide variety of errors in multiplication, especially the students with Learning Disabilities. In the traditional way of multiplication, 4 steps are used to multiply with large numbers: 1) multiply by the ones, 2) multiply by the tens, 3) multiply by the hundreds, and so on, and 4) add the products obtained in steps 1-3. During these steps, students with Learning Disabilities often make many errors in multiplication algorithms. For example, they write entire product of each column without regrouping or write tens value of each subproduct, and regroup ones value into next column, etc. The writer analyzed the common errors students with Learning Disabilities made in multiplication algorithms. The common errors made by students with Learning Disabilities are as follows:

1. Regrouping: Writes entire product of each column without regrouping.

6 6	3 0 2
× 2	× 7
---	---
1,2 1 2	2 1,0 1 4

2. **Writes tens value of each other subproduct, and regroup ones value into next column.**

```
  2
  6 6
  × 2
------------
  1 4 1
```

3. **Writes one value of each subproduct, but doesn't regroup tens value into next column.**

```
  1
  6 6
  × 2
---------
  1 2 2
```

4. **Process substitute: Adds digits of multiplicands, and multiplies.**

```
    +
  6   6    = 12
  x   2      × 2
----------------------
  2   4
```

5. **Attention to sign: Subtracts.**

```
    6 6
( - ) × 2
  ----------
    6 4
```

6. **No cross-multiplication.**

```
  66
× 24
------
1,224
```

7. **Misplace place value.**

1.

```
   1
  62
× 46
-----
372
248
-----
620
```

2.

```
  23
 345
 × 36
------
2070
1035
------
3,105
```

The above errors found in multiplication were the common error patterns seen among children with Learning Disabilities. Those errors did not include all the errors that students made in multiplication, but these errors were the common errors made by students with Learning Disabilities or students who had trouble multiplying whole numbers and decimals.

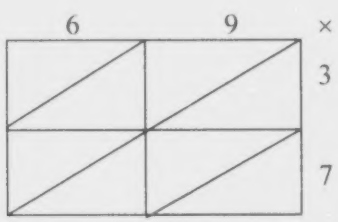
B. What Is the Lattice Method?

The Lattice Method dated back to the 1200s or before in Europe, [3] but he Chinese used the method far back to the1200s. The Lattice Method of multiplication appears in the first printed arithmetic book, printed in Treviso (Italy) in 1478. It shows this exact method and a variation as well as some variations of the long multiplication algorithm commonly taught today.[4] The Lattice Method had its name from the fact that when he did

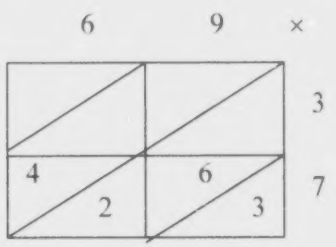
the multiplication, he was filling in a grid that looks like a lattice he might find ivy growing on.[4] Moreover, multiplication really takes three steps: *multiply*, *carry*, and *add*. The Lattice Method does all three steps separately. It is a quicker and different way to multiply two numbers, so it is really easier! It is really fun for children to fill the grids one by one. The following is the detailed illustration of the Lattice Method:

For example, multiply 69 × 37.

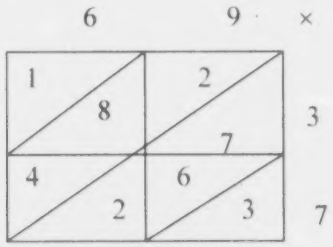
First, make a grid. Write the digits of one factor along the top. Write the digits of the second factor along the right. Divide each box diagonally. For example:



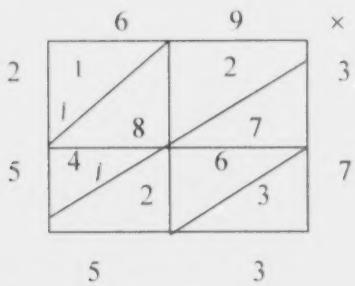
Next, multiply each digit along the top by the digit in the ones place along the side. Place the answers in the boxes.



Multiply the rest of the digits in the same way.



Add along the diagonals. Regroup if necessary.



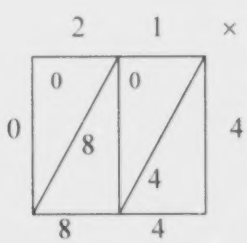
Write the digits in order from left to right. You have found the product: 2,553.

Finally the product of 69 × 37 is 2,553.

C. How to Use the Lattice Method to Teach Students with Special Needs?

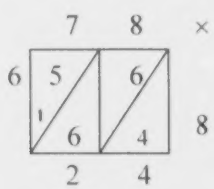
Students with Learning Disabilities might not be familiar with this method. Proper instructions to those students will help them to understand the method. The following are the steps used for the Lattice Method to teach multiplication with whole numbers:

1. Use 2 digits times 1 digit without regrouping. For example: 21 × 4.



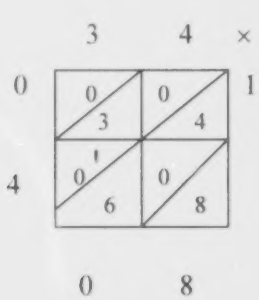
Write the digits in order from left to right. Add along the diagonals from right to left. Read the product from left to right. You've found the product: 8 4 rather than 4 8 0. Students might write 0 8 4, but students were told to write the product: 8 4. Students repeat using 2 digits times 1 digit without regrouping until they have mastered the way of multiplication.

2. Use 2 digits times 1 digit with regrouping. For example: 78 × 8.



Write the digits in order from left to right. Add along the diagonals from right to left. You've found the product: 624. Repeat using 2 digits times 1 digit with regrouping until students have mastered the way of multiplication.

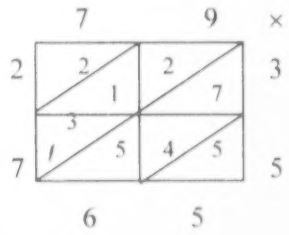
3. Use 2 digits times 2 digits without regrouping. For example: 34 × 12.



Students are taught to start multiplying each digit along the top by the digit in the ones places along the sides, i.e., 2 times 4 = 8, 2 times 3 = 6. But it does not affect the computation if students start multiplying the tens place, i.e. 1 times 4 = 4, 1 times 3 = 3. Write the digits in order from left to

right. Add along the diagonals from right to left. You've found the product: 408. Repeat using 2 digits times 2 digit without regrouping until students have mastered the way of multiplication.

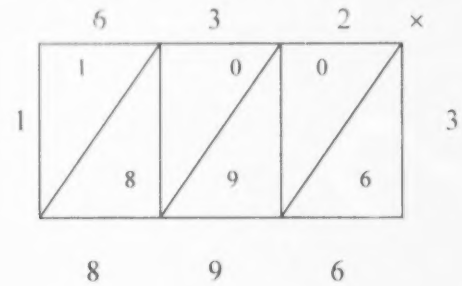
4. Use 2 digits times 2 digits with regrouping. For example: 79 × 35.



Students are taught to start multiplying each digit along the top by the digit in the ones places along the sides, i.e., 5 times 9 = 45, 5 times 7 = 35. But it does not affect the computation, as mentioned above, if students start multiplying the tens place, i.e. 3 times 9 = 27, 3 times 7 = 21. This can be used for more than 2 digits times more than 2 digits with or without regrouping. It is found that first multiplying the tens place, hundreds place, thousands place … is especially better when students multiply long digit numbers, i.e. 4,596 × 678, 67,406 × 3,057 ….

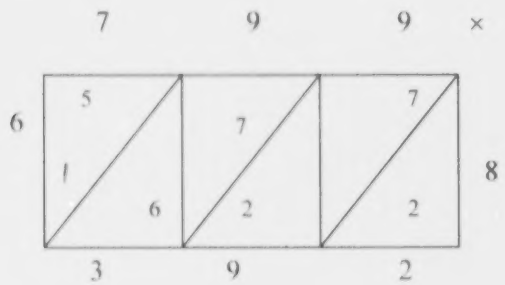
Now write the digits in order from left to right. Add along the diagonals from right to left. You've found the product: 2,765. Repeat using 2 digits times 2 digit with regrouping until students have mastered the way of multiplication.

5. Use 3 digits times 1 digit without regrouping. For example: 632 × 3.



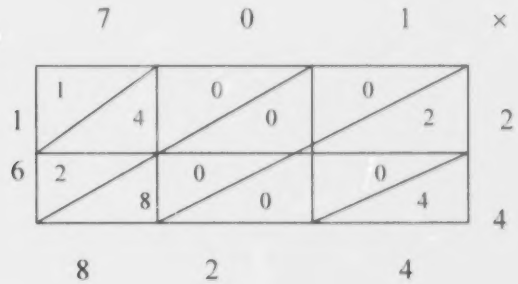
Write the digits in order from left to right. You've found the product: 1,896. Repeat using 3 digits times 1 digit without regrouping until students have mastered the way of multiplication.

6. Use 3 digits times 1 digit with regrouping. For example: 799 × 8.



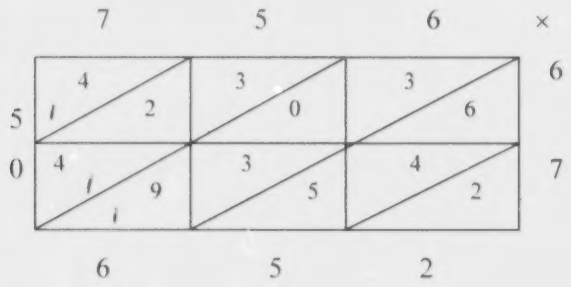
Write the digits in order from left to right. You've found the product: 6,392. Repeat using 3 digits times 1 digit with regrouping until students have mastered the way of multiplication.

7. Use 3 digits times 2 digits without regrouping. For example: 701 × 24.



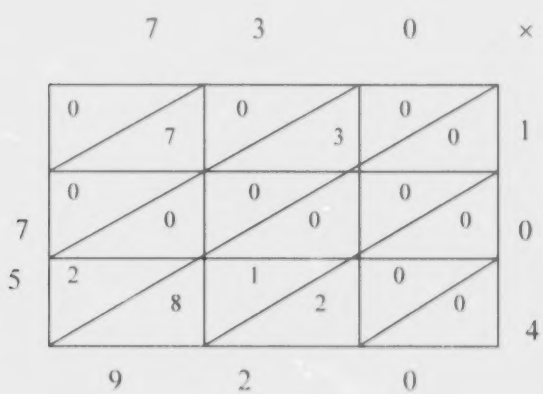
Write the digits in order from left to right. You've found the product: 16,824. Repeat using 3 digits times 2 digits without regrouping until students have mastered the way of multiplication.

8. Use 3 digits times 2 digits with regrouping. For example: 756 × 67.



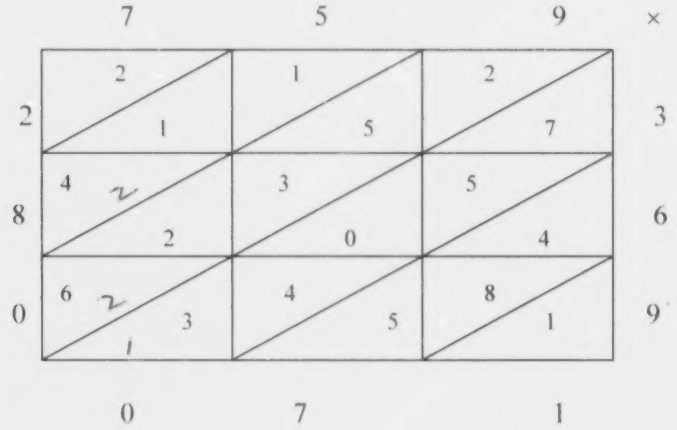
Write the digits in order from left to right. You've found the product: 50,652. Repeat using 3 digits times 2 digits with regrouping until students have mastered the way of multiplication

9. Use 3 digits times 3 digits without regrouping. For example: 730 × 104.



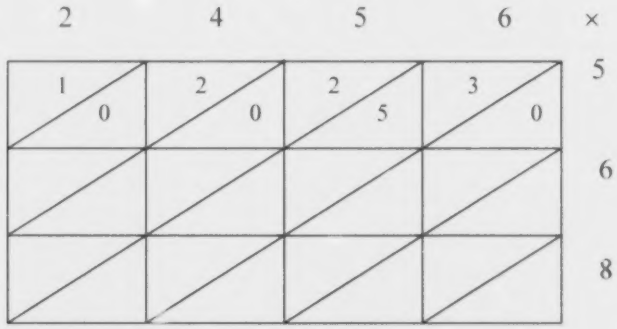
Write the digits in order from left to right. You've found the product: 75,920. Repeat using 3 digits times 3 digits without regrouping until students have mastered the way of multiplication.

10. Use 3 digits times 3 digits with regrouping. For example: 759 × 369.



Write the digits in order from left to right. You've found the product: 280,071. Repeat using 3 digits times 3 digits with regrouping until students have mastered the way of multiplication.

So far students have learned how to do multiplication with and without regrouping. As stated in 4 above, it does not affect the result of algorithms, students can start multiplying the tens place, hundreds place, and so on and so forth. This is better when long digit multiplication is involved. For Examples: 2,456 × 568.



Students can start multiplying each digit along the top by the digit in the hundreds place along the side in the example of 2,456 × 568 above, i.e.,5 × 6 = 30, 5 × 5 =

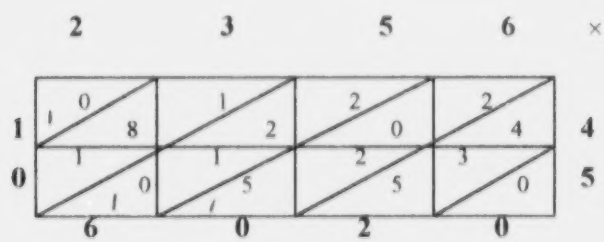
25, and $5 \times 2 = 10$. Then multiply the rest of the digits in the same way. Starting multiplying by the digit in the hundreds place or even higher benefits some students who have difficulty with too many numbers in algorithms.

Frequent mixed practice of multiplication with whole numbers can be used with more than 2 or 3 digits, i.e., 3 digits time 3 digits with or without regrouping, 4 digits times 2 or 3 digits with or without regrouping, etc. Some of the students can use the multiplication table if they are not familiar with basic math facts while doing the multiplication with whole numbers by using the Lattice Method. They are also allowed to use a calculator to check the answer. Teachers do not put a mark in the wrong items the student did. Teachers should ask the student why he did them wrong. Then let him correct them by him. This helped students build self esteem and self-confidence, and avoided their frustration in multiplication algorithms.

D. Lattice Method Used in Multiplying with Decimals

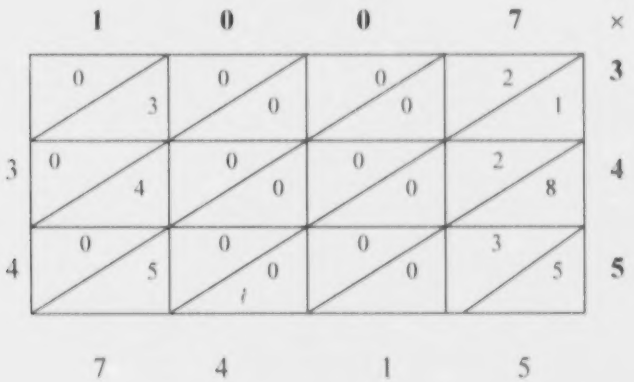
Students with Learning Disabilities often have more trouble multiplying decimals than multiplying whole numbers, but the Lattice Method can help students multiply decimals exactly in the same way as multiplying the whole numbers illustrated above. For example, $23.45 \times 0.45 = ?$ and $1.007 \times 0.345 = ?$, students are told that 23.45 and 0.45 are regarded as if they were 2345 and 45, and 1.007 and 0.345 regarded as if they were 1007 and 345, respectively. After the product is obtained, students are told to move necessary decimal places from right to left as required.

For example: **23. 56 × 0.45.**



Write the digits in order from left to right. You've found the product: 106020. Now students are told to move 4 decimal places from right to left. The product of Decimal multiplication is 10.602 (10 and 602 thousandths).

More example: **1.007 × 0.345.**



Write the digits in order from left to right. You've found the product of 1007 times 345 is: 347415. Now students are told to move 6 decimal places from right to left. The product of decimal multiplication is 0.347415 (zero point three four seven four one five). As soon as students obtained the product of the decimal multiplication, a comma was not used, because the comma might cause students to get confused when they moved the decimal places. Repeat using the Lattice Method to multiply decimals until the students have completely mastered the way of decimal multiplication with multi-decimals.

When students were able to use the Lattice Method through mixed practice, they were allowed to make grids themselves. The teacher only gave them the multiplication items. The grids in some samples (in Appendix C) were made by students themselves. Some students liked making a grid. Therefore, that helped them enhance more interest and self-esteem and self-confidence in doing multiplication with whole numbers and decimals.

E. Analysis of the Test Results

Statistically significant differences between the two tests were found on the pre-test (significant at the 0.01 level) and the post-test (significant at the 0.05 level) on the basis of the formula of Chi-square. Students obtained much higher scores in the test with the Lattice Method.

The formula of Chi-square is as follows: [1]

$$X^2 = \sum \frac{(e-o)^2}{e}$$

in which

X^2 = Chi-square

Σ = sum of

$(o-e)^2$ = the square of the difference, for each category, between what was observed (o) and what was expected (e). Each square is divided by the appropriate expected frequency, and the results are then summated. [1]

The Chi-square value of 33.8 was obtained from the pre-test, which was greater than 20.090, so it is significant at the 0.01 level.[1] Therefore, the null hypothesis was rejected. It was noted that the standard error of mean (SeM) and standard deviation (S.D.) of the sample tested were computed with the formula: [1]

$$SeM = \frac{S.D.}{\sqrt{n-1}}$$

In which

SeM = standard error of mean

S.D. = standard deviation of the sample

N = size of sample

$$S.D. = \sqrt{\frac{\sum X^2}{N - 1}}$$

Where S.D. = standard deviation

X^2 = the square of the amount by which each score differs from the mean

N = the number of scores (use N –1 if 15 scores or fewer)

$\sqrt{\ }$ = the square root of the quotient

Chapter IV

Findings

In a study of multiplication errors committed by students with Learning Disabilities Miller and Milam (1987) found that the majority of the errors were due to a lack of prerequisite skills. Errors in multiplication were primarily due to a lack of knowledge of multiplication facts and inadequate addition skills. Miller and Milam concluded, [4]

> Many of the errors discovered in this study indicated a lack of student readiness for the type of task required. Students were evidently not being allowed to learn and practice the skills necessary for higher order operations. The implications are obvious: students *must* be allowed to learn in a stepwise fashion or they will not learn at all. (p. 121).

It was found that students with Learning Disabilities made multiplication errors owing to lack of proficiency in basic number facts. They did not know the basic rules for doing multiplication. These errors indicated clearly that there were many ways to do a few things wrong. Proper instructions can greatly reduce the repetition of student errors in computation. Students were unable to multiply two or three-digits in the traditional way, but they were able to multiply more than two digits with the Lattice Method with more than 90% accuracy. Students in the writer's classes were found that they were able to multiply more than 2 multipliers and got 100% accuracy in multiplication.

A. Students' Test Results Shown by Using the Traditional Way of Multiplication

The Multiplication Test (*Appendix A*) was constructed by the writer on the basis of 10 multiplication items that were exactly copied from *KeyMath-R*, *WRAT3*, and *Woodcock-Johnson* respectively.[7-8] Before the writer taught the Lattice Multiplication to students with Learning Disabilities, he used the constructed test to pre-test the students. The test result was as follows:

Table 1. The Results of Pre-test with the Traditional Way of Multiplication

Students	Age	Raw Score	% Accuracy
RT	15.5	2	20%
VH	14.1	3	30%
AM	14.3	3	30%
CC	15.7	3	30%
BG	14.6	4	40%
IZ	14.3	5	50%
RM	15.0	5	50%
JH	14.2	6	60%
DD	14.5	5	50%

Sum = 36

Mean = 4 Average Accuracy: 40%

Standard Deviation (S.D.) = 1.32

Standard Error of the Sample Mea (SeM) = 0.165

Table 1 shows that students used the traditional way of multiplication to complete the test. Their mean raw score is 4 and the average accuracy accounts for 40%.

B. Students' Test Results Shown by Using the Lattice Method

After these students learned how to multiply by two and three-digit numbers, they were tested again with the exact same test (Appendix A). The result of the test showed that these students with Learning Disabilities made a big success. Most of them got 100% accuracy. See the result of the test in Table 2 below:

Table 2. The Results of Post-test with the Lattice Method

Students	Age	Raw Score	% Accuracy
RT	15.11	10	100%
VH	14.7	10	100%
AM	14.9	10	100%
CC	16.3	9	90%
BG	15.2	9	90%
IZ	14.9	10	100%
RM	15.6	10	100%
JH	14.8	9	90%
DD	14.11	10	100%

Sum = 87

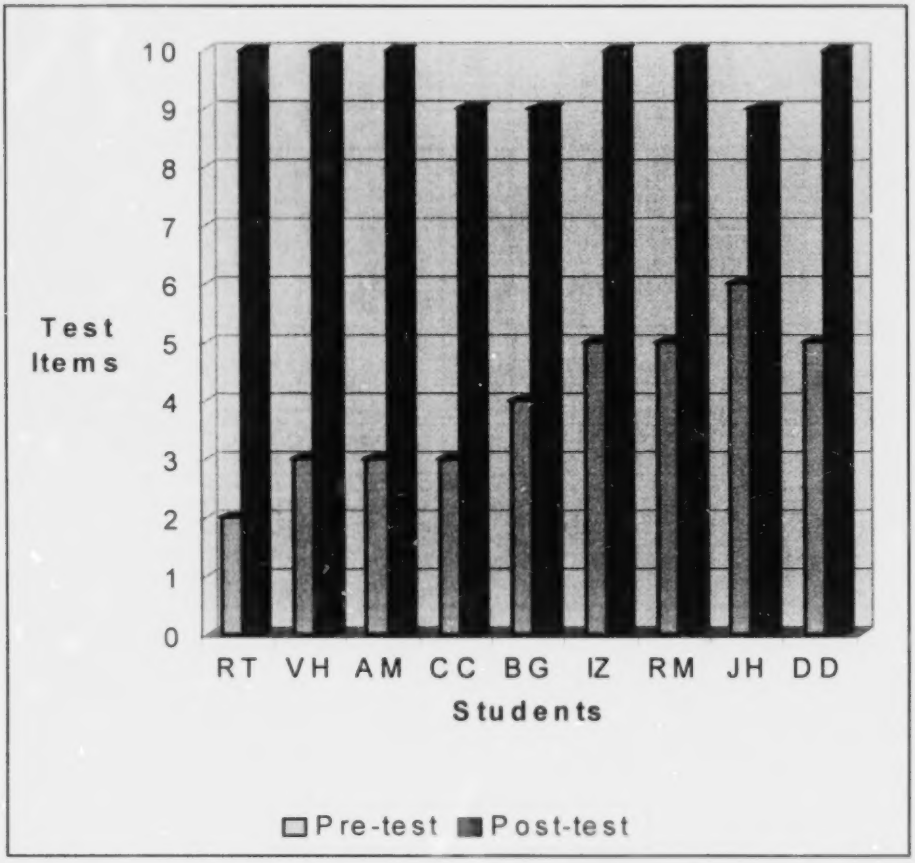
Mean = 9.7 Average Accuracy: 97%

Standard Deviation (S.D.) = 0.5

Standard Error of the Sample Mea (SeM) = 0.063

Table 2 shows that the students used the Lattice Method to complete the math test. Their mean raw score is 9.7 and their average accuracy accounts for 97%. The result shown above indicated that students with Learning Disabilities were able to do multiplication with 2 or 3 digit numbers with more than 97% accuracy, most of whom obtained 100% accuracy in the multiplication test. As compared with the scores of the pre-test, the per cent of average increase in their final test scores was 141.7% (87 – 36) / 36.

Figure 1: The Comparison Between Pre-test and Post-test.



The bar graph in Figure1 above shows the test scores obtained from the use of the traditional way of multiplication (**pre-test**) and the use of the Lattice Method (**post-test**) with the test constructed by the writer on the basis of the *WRAT, Keymath-R*, and *Woodcock-Johnson Psycho-Educational Battery* (Appendix A).

The Lattice Method was hardly used in teaching students with Learning Disabilities. Practice proved that the Lattice Method was effective and useful to be used in teaching multiplication with whole numbers and decimals to students with special education or students who have trouble in multiplication algorithm.

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Chapter V

Conclusions

The writer found that the Lattice Method was a quick and easy way to multiply more than two digit numbers. Students with Learning Disabilities had trouble multiplying with whole numbers and decimals by the traditional way. Therefore, they made a wide variety of mathematical errors in the traditional way. Students wrote entire product of each column without regrouping. They wrote tens value of each other subproduct and regrouped ones value into next column. They wrote one value of each subproduct, but didn't regroup tens value into next column. They added digits of multiplicands and multiplied. They misjudged computation signs. They did not use cross-multiplication and misplaced place value. These errors were the commonly made errors by students with Learning Disabilities when they used the traditional way of multiplication with whole number and decimals.

The writer emphasized that the Lattice Method, if properly instructed, could help students with Learning Disabilities to overcome much difficulty in multiplication. Most obviously, students with Learning Disabilities were able to do multiplication with the Lattice Method much better than with the traditional way. It was also noted that in the writer's classes students were unable to do multiplication with the traditional way, but they skillfully used the Lattice Method to multiply with multi-digit numbers with more than 97% accuracy. This was also true of classes in other states. For instance, Joye Shirks, MeD, a certified special education teacher from Sparta Area School District of Wisconsin, wrote in the letter of August 31, 2000:

> After Mr. Gu introduced the Lattice Method to me, I in turn introduced it to my students. They quickly caught on to the concept and actually enjoyed doing their multiplication. This method can help improve academic success, but more importantly it improves self-esteem and self-confidence in the students. ... It has been a great success for me and I am sure it has been just as successful for the others that have tried it.

The Lattice Method was hardly used in teaching students with Learning Disabilities. Practice proved that the Lattice Method was effective and useful in teaching

multiplication to students with special education or students who have trouble in multiplication algorithm.

It is hoped that more and more special education teachers throughout our nation will use the Lattice Method, the practice of which has proved that the method is quick and easy and effective. It is hoped that this method will continue to have an impact on the improvement of academic performance in multiplication made by students with special education.

Appendix A

Math Test

Multiply.

1.
$$\begin{array}{r} 23 \\ \times\ 3 \\ \hline \end{array}$$

2.
$$\begin{array}{r} 20 \\ \times\ 7 \\ \hline \end{array}$$

3.
$$\begin{array}{r} 47 \\ \times\ 6 \\ \hline \end{array}$$

4.
$$\begin{array}{r} 502 \\ \times\ 8 \\ \hline \end{array}$$

5.
$$\begin{array}{r} 83 \\ \times 20 \\ \hline \end{array}$$

6.
$$\begin{array}{r} 49 \\ \times 23 \\ \hline \end{array}$$

7.
$$\begin{array}{r} 34 \\ \times 21 \\ \hline \end{array}$$

8.
$$\begin{array}{r} 512 \\ \times\ 3 \\ \hline \end{array}$$

9.
$$\begin{array}{r} 823 \\ \times\ 96 \\ \hline \end{array}$$

10.
$$\begin{array}{r} 102 \\ \times\ 12 \\ \hline \end{array}$$

Note: Items from 1 to 6 were copied from KeyMath-R, 1988 edition.[2] Items from 7 to 9 were copied from WRAT3 (Wide Range Achievement Test), 1993 edition.[7] Item 10 was copied from Test 24 of Woodcock-Johnson, 1989 edition.[8]

Appendix B

What Do the Professionals Say about the Lattice Method?

The following are the excerpts I extracted from the letters I received from special education teachers, professors, researchers, and educators about the Lattice Method used in teaching children with special needs in our nation:

Tricia Brown, M.A., Vice Principal and certified special education teacher from Sacramento, California, says:

This method helps students who are weak performing multiplication with one or more multipliers. At first, most students are unable to do multiplication by two or more multipliers. With the Lattice Method, students eventually able to do multiplication with two ore three, even four multipliers. This has proved very successful in teaching students with special education needs. … When I taught students here as a Resource Teacher in California, I used the Lattice method, too. It was again very successful in helping special education students learn how to do multiplication. This method impacts improving students' math skills and it has proven beneficial in our teaching students with learning disabilities.

Scott Kober, a certified special education teacher from Northwest Arctic Borough School District, Alaska, says:

Practice has proven that this method is very useful in teaching my students an easy way to solve math problems. I believe the Lattice Method has impacted my student's success in math education. I have come to find that the Lattice Method strategy teaching mathematics is of importance and significance for it has helped my students learn multiplication, especially those who have struggled doing multiplication with more than two multipliers. … Wenyuan Gu … offered many teaching strategies throughout my time there that helped make learning fun and easier for my students. The Lattice Method was among one of the valuable teaching tools I used. My students made great progress with this method, especially when multiplying multi-digit numbers. … Such errors, however, have dramatically reduced since I began teaching the Lattice Method way to solve problems. The Lattice Method, indeed, has helped and is continuing to help my students avoid making such common errors and as a result, be more successful with multiplication and overall mathematics. I hope this unique method of teaching multiplication will continue to be implemented in classrooms around the world.

Tim Shirks, a certified special education teacher, Winona, Minnesota, says:

I used the Lattice Method Wenyuan Gu introduced to me two years ago. Teaching multiplication to students with special education is very successful in my class because of that method I used. I also introduced the method to other special education teachers in other schools, who told me that it was a great success in their classes. The method can improve academic level in multiplication for those who have trouble in doing multiplication. I find that this method can help students avoid many errors in multiplication, especially avoiding misplacing place values, which is the most common error that I have seen students make in a traditional way of multiplication.

I have used this method ever since Wenyuan Gu introduced it to me two years ago. In the past two years, students enjoyed using this method. Students improved their academic success and raised their academic level.

Kent Kramer, M.S., a certified special education teacher Holmen High School, Wisconsin, says:

… the Lattice Method he introduced to me nearly three years ago. I have successfully been using this method in teaching students with special needs in my school district. I have also shared this method with other teachers in our district. This has made a great impact on improving the multiplication skills of these students.

I began to use the method he introduced to me in September of 1998. I find that the method can improve academic skills in multiplication for those who have learning disabilities in math. In addition, this method can help students avoid many errors in multiplication, especially avoiding a misplaced value, which is the most common error that students with Learning Disabilities make. Students who have had trouble learning multiplication in the traditional way seem to be better able to grasp the concept by using the Lattice Method. The Lattice Method is and will continue to be an impact to and benefit special education students in the future.

Aaron L. Fisher, Special Education Director, Academy at Swift River, Massachusetts, says:

Rather than simply presenting information to his class, Mr. Gu stresses specific skills and strategies that acknowledge the students' needs. On such example is his Lattice method of multiplication. The Lattice method is practical, helpful, and constructive for teaching special education students, especially for students with learning disabilities. This method can help improve students' skills in multiplication. More importantly, this method can help students avoid errors in multiplication, especially those that associated with place value, regrouping and carrying. Using the Lattice method helps students avoid these most common errors. The method can also help students with special needs to increase academic levels in mathematics.

Joye Shirks, Med, a certified special education teacher, Sparta Area School District, Wisconsin, says:

… Lattice Method of Multiplication was very impressive and an impact in improving students with special needs in their academic success. The improvement was shown in our teaching to students with Learning Disabilities since we used the method Wenyuan Gu introduced to us two years ago.

Since Wenyuan Gu introduced to me the Lattice Method two years ago, I have used the unique method to teach these students with great success. Students quickly caught on to the concept and actually enjoyed doing their multiplication. This method can help improve academic success, but more importantly it improves self-esteem and self-confidence in the students. Because the method is wonderful, I introduced it to other special education teachers in other schools. They used the method and it has turned out to be a great success for them to teach students with special needs.

Mary Qin, a certified special education teacher, Bayside, New York, says:

Mr. Gu's Lattice Method is an excellent method in teaching math to the students with special needs. This method is very useful and practical for students to learn how to do multiplication, especially for those who have difficulty to do multiplication with more than two multipliers. I believe that it will be a great benefit and influential of math teaching in this country.

Lynn Summerill, M.A., Educational Director, Eagleton School, Massachusetts, says:

The Lattice Method he used in teaching students with special needs is a great success. Because of the success, the Lattice Method is widely used in schools in other states, too. Former colleague teachers have used the method in their schools since they left our school. This method is easy for our American students to grasp. Students find this method fun and less frustrating than our traditional format used in multi digit multiplication instruction. Students and teachers have been amazed at the reduction of errors using the Lattice method. Place value errors commonly seen in traditional multi digit computation are significantly reduced. Careless errors have decreased specially in students who have grapho spatial motor difficulties. Students have improved their academic levels because of the unique method. This method is particularly effective with Learning Disabled special needs students. He is writing the paper regarding the Lattice Method used in teaching multiplication with whole numbers and decimals to students with learning disabilities so that more and more teachers will use the Lattice Method throughout our nation.

I have found Wenyuan Gu to be very knowledgeable in mathematics instruction. He is familiar with many valuable techniques and methods related to the teaching of mathematics, which are unfamiliar in the United States. He can communicate these methods quickly and efficiently. I feel he can make monumental strides in assisting and increasing our students math scores by introducing Chinese teaching methods to our current curriculums in mathematics.

Toney Lee, a special education teacher, Eagleton School, Massachusetts, says:

The Lattice Method is very useful because the method helps students overcome the above errors in multiplication algorithm. Therefore, it ensures the students to be successful in academic learning. The method not only benefits our children in learning mathematics, but also improves these students' academic levels. It is hoped that the method will continue to be a great impact in teaching students with Learning Disabilities multiplication with more than two multipliers.

Sherry Xiao Peng, a certified special education teacher in California, says:

This method is very impressive. It is an impact to the improvement of students' success in learning how to do multiplication with more than two multipliers.

I've found that the Lattice Method is practical and easy to learn. I've used the method in our school and shared it with my colleagues since Wenyuan Gu introduced it to me.... The advantage of the Lattice Method is to improve students' success in doing multiplication and enhances their interest in math because many common errors can be avoided by using this method. In addition, this method is also useful in teaching those who have trouble doing multiplication with more than 2 multipliers. Many of our students who had trouble learning multiplication have made progress in multiplication with more than two multipliers, thus improving their math skills.... I believe that the method has benefited and will continue to benefit our students. I give Wenyuan Gu many thanks for introducing such a unique method to us.

Anpei Jiang, a certified special education teacher in New Jersey, says:

I used this method introduced by Mr. Wenyuan Gu in my class. It was a great success. Let me take the example of multiplying with a 3-digit factor. I have discovered that after my using the Lattice Method the students can keep the digits in the partial products linked up in the proper columns.... My students and I are happy with the effective method.

I hope that more and more people will use the method because it helps students improve their academic success. I will introduce the method to other teachers too...

Xiaomei Xu, family physician, FAAFP, MD. M.S., Inland Center Medical Group, California, says:

From the medical point of view, the [Lattice] method he used is very specific and practical. The method can avoid students misplacing place value and mistakes or errors in multiplication. The method can help these students gain interest in learning the multiplication more than the way they use in the traditional way of multiplication.

As we know, students with Learning Disabilities (LD) have difficulty finishing the task, which involves in mathematics, because of neurological disorders....The Lattice method opens up a new whole world to those children. The method is a simple, fun and

easy way in mathematics computation. It helps students gain interest in learning the way of multiplication. The stimulating box shown in the Lattice Method helps the brain receive information in an interesting way. Thus it is a marvelous way of teaching such mathematics to disabled students.

Lyelle L. Palmer, Ph.D., Professor of Special Education (Learning Disabilities), Department of Special Education, Winona State University, Minnesota. Scientist, the Minnesota Learning Resource Center, says:

His instruction emphasizes the Lattice Method for assistance in producing multiplication calculations, which is rather unique as a success tool to give confidence to students who previously found multiplication impossibly complex. Students avoid misplacing place value and increase accuracy in products resulting from multipliers with more than two digits. Decimal multiplication becomes accurate also, with especially strong implications for understanding and calculating money problems. He has awakened for us an awareness of the value of the lattice method specifically because of his Chinese math background. Since accepting a position as a teacher in a school for students with learning and behavioral difficulties, his skills have made him successful and appreciated by students and staff teachers…

Frank Rocco, Ph.D. Professor of Special Education and Chairperson, Department of Special Education, Winona State University, Minnesota, says:

Wenyuan Gu has been successful in teaching students with special needs in Eagleton School. In teaching mathematics, he used the Lattice Method, which is very important for teaching special education students. The method can help improve academic skills for those who have learning disabilities in mathematics because this method can avoid students misplacing place value in multiplication.

Katherine J. Foster, a certified special education teacher, Lee Public School District, Massachusetts, says:

The Lattice Method is very useful for teaching students with special needs. This method can help improve academic skills in multiplication for those who have learning disabilities in multiplication. I have found that this method can help students avoid making errors in multiplication, especially in avoiding misplacing place value in multiplication, which is a common error that students with learning disabilities make. This method has made an impact on student success and grade level in math skills.

Bruce Bona, Executive Director, Eagleton School, Massachusetts, says:

His teaching multiplication with Lattice Method is a great impact to academically improving students with special needs in our school.

Appendix C

Four samples of the Lattice Method Done by Students

Sample 1. Student JH made grids by himself to multiply with three digits (p.30). He got 100% accuracy in multiplication with the Lattice Method.

Sample 2. Student MJ made grids by himself to multiply with decimal numbers (p. 31). He was unable to multiply decimals with the traditional way, but he got 100% in multiplication with the Lattice Method.

Sample 3. Student RM practiced the Lattice method with mixed numbers (p.32). He was able to multiply with whole numbers and decimals with 50% accuracy, but he got 100% accuracy in multiplication with the Lattice Method.

Sample 4. Student IZ practiced the Lattice Method with more than three digits in multiplication (p. 33). He got 100% in multiplication with the Lattice Method.

11-16-00

JH

$632 \times 455 = 287,560$

	6	3	2	
2	24	12	08	4
8	30	15	10	5
7	30	15	10	5
	5	6	0	

	6	5	4	
2	18	15	12	3
1	12	10	08	2
1	18	15	12	3
	2	4	2	

$654 \times 323 = 211,242$

A+

MJ
11-17-04

$7.83 \times 0.34 =$ 2.6622

C

	7	8		3	
2	2/1	2/4		0/9	3
6	12/18	3/2		1/2	4
	6	2		2	

$0.875 \times 1.2 =$ 1.05

C

	0	8	7	5	
	0/0	0/8	0/7	0/5	1
1	0/0	1/6	1/4	1/0	2
	0	5	0	0	

$7.953 \times 0.34 = 2.70402$

C

	7	9	5	3	
2	2/1	2/7	1/5	0/4	3
7	22/18	3/16	2/0	1/2	4
	0	4	9	2	

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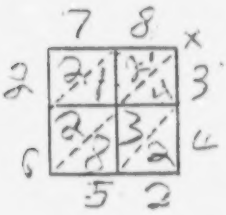
Ralph

Use the lattice method to multiply:

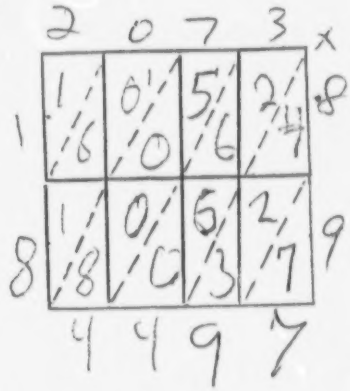
78 × 34 = 2652



C

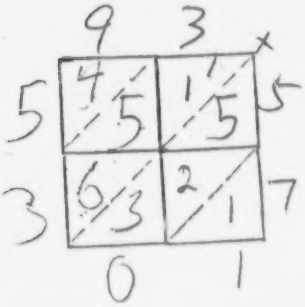
A

2,073 × 89 = 184497



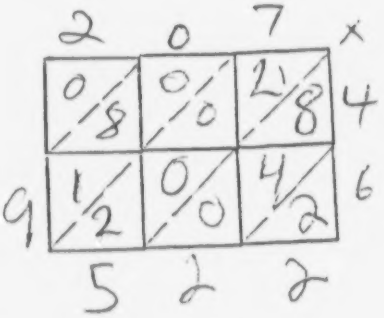
C

93 × 57 = 5301



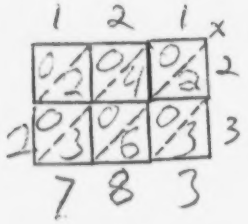
C

207 × 46 = 9522



C

121 × 23 = 2783



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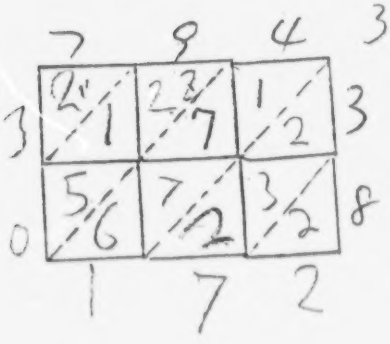
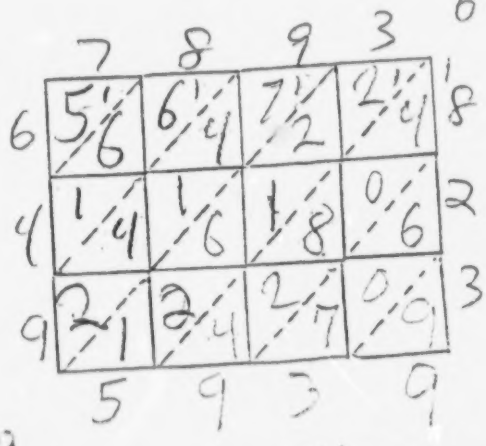


C

794 × 38 = 30172

30,172



C

7,893 × 823 = 6,495,939

6,495,939

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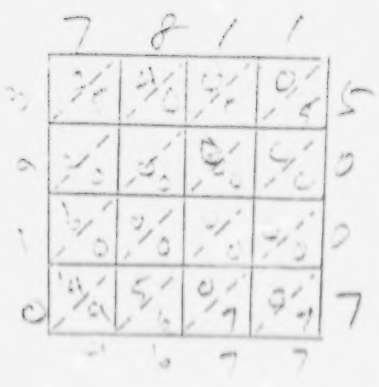
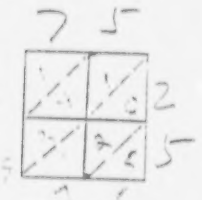
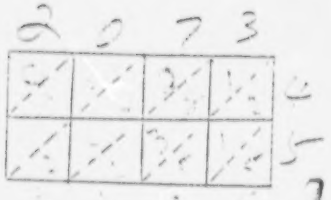
Name Jess Date 5-7-09

Lattice Method:

7,811 × 5,207 = [illegible]

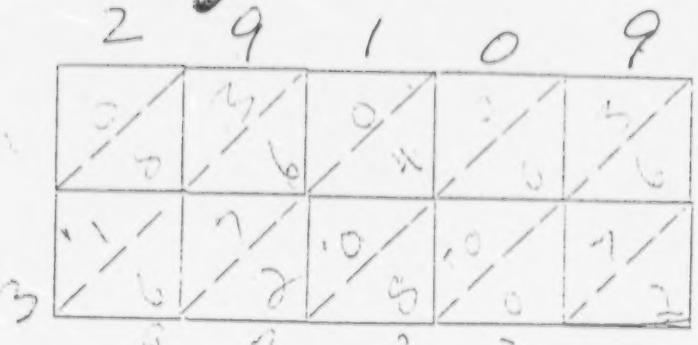




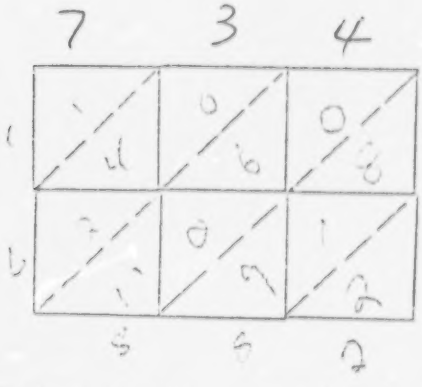


2,073 × 45 = [illegible]

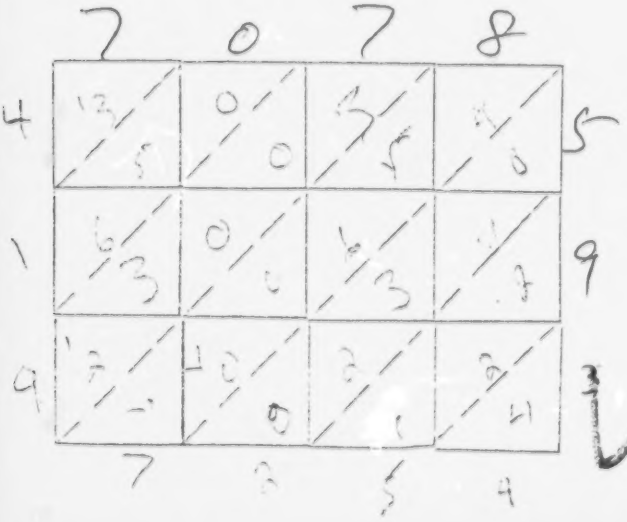
29109 × 48 = 1,397,232

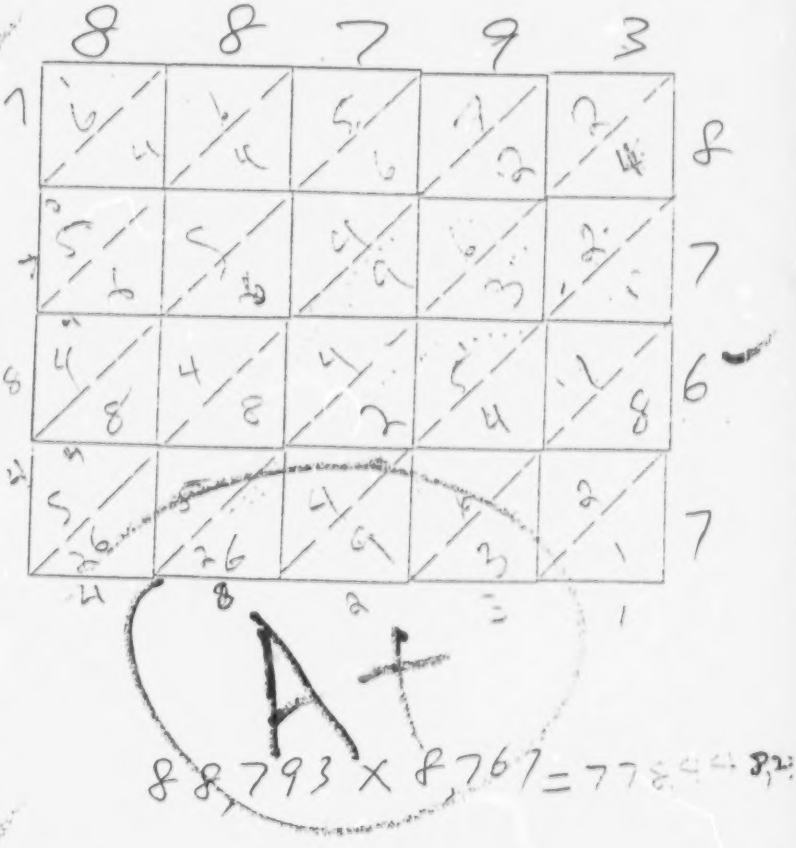


734 × 23 = 16,882



7,078 × 593 = 4197254





88,793 × 8,767 = 778,444,831

A+

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